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Office of Science and Technology Policy
Executive Office of the President
Washington, DC 20500

Goals For A National Partnership in Aeronautics Research and Technology

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About the National Science and Technology Council

President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This cabinet-level council is the principal means for the President to coordinate science, space, and technology policies across the Federal Government. NSTC acts as a "virtual" agency for science and technology to coordinate the diverse parts of the Federal research and development enterprise. The NSTC is chaired by the President. Membership consists of the Vice President, Assistant to the President for Science and Technology, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other senior White House officials.

An important objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in areas ranging from information technologies and health research, to improving transportation systems and strengthening fundamental research. The Council prepares research and development strategies that are coordinated across the Federal agencies to form an investment package that is aimed at accomplishing multiple national goals.

To obtain additional information regarding the NSTC, contact the NSTC Executive Secretariat at 202-456-6100.

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976. OSTP's responsibilities include advising the President in policy formulation and budget development on all questions in which science and technology are important elements; articulating the President's science and technology policies and programs, and fostering strong partnerships among Federal, State, and local governments, and the scientific communities in industry and academe.

To obtain additional information regarding the OSTP, contact the OSTP Administrative Office at 202-395-7347.

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Goals For a National Partnership in Aeronautics Research And Technology

EXECUTIVE SUMMARY

U.S. firms and workers lead the world in manufacturing aircraft, engines, avionics, and air transportation system equipment. In the process, they are making a major contribution to our nation's security and economy. Aeronautics manufacturing provides military power, high technology, high-quality jobs, and makes a positive contribution to the U.S. balance of trade and the general prosperity of all American citizens. American leadership in aeronautics also provides global benefits through the economic and cultural exchange and integration made possible by a truly global transportation system.

The growth in this industry, since the infancy of powered flight, has been the result of a strong partnership between the government, industry, and universities. Government investment in aeronautics has been focused on science, technology, infrastructure and military aviation. This investment, worked in close partnership with industry, provided the conditions for industry success in aeronautics.

Today, however, the aeronautics industry is facing a number of difficult, new challenges. First, the end of the Cold War has permitted a reduction in defense expenditures, including significant cut backs in the development of new aircraft and engines. Second, the weak financial state of the global airline industry has seriously affected orders, backlogs, and deliveries of new civil aircraft. Third, foreign governments have strongly supported the development of their own aeronautics industries through major investments in infrastructure, technology and development programs, challenging U.S. competitiveness in this industry.

Although the combination of these factors has had a significant impact on the aeronautics industry, the United States is still the leader in aeronautics technology and manufacturing. We must maintain leadership in this global industry if we are to retain the national security and economic benefits that derive from aeronautics. Nationally, we have the infrastructure -government, industry, and universities - to maintain leadership. We must now renew our focus on partnership to meet national challenges and accomplish national goals. However, we must also reexamine our traditional partnership in the context of the current and future challenges. Clearly, we must develop an integrated view of aviation system performance and affordability.

Together, we must take action -- action that will ensure that the United States maintains a strong and competitive aeronautics manufacturing industry. This document provides a framework for a government, industry, and university partnership in aeronautics research and technology (R&T) development. Working together, the Administration, industry, and universities have identified three key goals that define this partnership and which will help the U.S. aeronautics industry maintain its global competitiveness:

- Maintain the superiority of U.S. aircraft and engines
- Improve the safety, efficiency and cost effectiveness of the global air transportation system
- Ensure the long-term environmental compatibility of the aviation system

Over the next several months, NSTC, in partnership with industry and academia, will perform a national assessment to guide the direction and character of the Federal investment in U.S. civil aviation technology for the future. The assessment will include development of top-level technical goals, roadmaps to achieve the goals, partnership mechanisms, and analyses of benefits, priorities, opportunity costs, roles and responsibilities, and interrelationships with other national initiatives.

This document, together with the detailed national assessment, will provide the blueprint for our public-private partnership for the future, as well as communicate with the American people and the Congress our proposed investment portfolio. The NSTC welcomes comments and participation in the planning process as we move to ensure the technology base and infrastructure for a vital aviation industry and transportation system.

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Goals for a National Partnership in Aeronautics Research and Technology

I. Context For A Renewed Partnership

The aerospace industry is an important part of our nation's economy. In 1994, the aerospace sector produced an estimated $102 billion in manufactured goods. It exported products worth $40 billion to 181 countries worldwide. These exports consisted almost exclusively of aeronautics products: aircraft, engines, and aviation system equipment. The aeronautics industry produced the largest trade surplus of any U.S. manufacturing industry, approximately $25 billion in 1994.

Still, U.S. aeronautics shipments have been declining for several years, and in 1994 were down 12 percent in real terms from 1993. Sales have been declining in both the civil and military sectors, the latter due to the rapid drawdown of defense budgets worldwide. This decline in both the civil and military sectors has had a severe impact on employment and manufacturing infrastructure. There are approximately a third fewer engineers and scientists in the aeronautics industry today than there were in 1991.

Economic recovery should help re-establish the commercial demand for large aircraft and components for airlines, as well as corporate, general aviation, and rotary wing aircraft. Long-term increases in demand over the next two decades--based on projected growth in airline traffic and a need for replacement of older, noisier, and less fuel- efficient aircraft--promise to renew growth within these segments of the aerospace industry. Overall, the industry expects to deliver over 14,000 transport aircraft during the next 20 years at a value of nearly $1 trillion.

On the military side, the Department of Defense devotes about one-third of its budget to the research, development, operation, and support of aircraft. Further, there are no substitutes on the horizon that offer the combination of firepower and mobility offered by aircraft -- aircraft will remain an important part of the force structure for the foreseeable future. The United States will continue to need the world's best military aircraft, and a preeminent position in the global aircraft market is necessary to achieve this aim.

While the United States still provides the largest market for commercial aircraft purchases, its share of the global market has been shrinking for some time. Exports are therefore increasingly critical to the health of the U.S. aeronautics industry. Important in this regard is the rapidly expanding Pacific Rim market. Exports of widebody, long-range aircraft to Asian markets are expected to experience the greatest increase since this region accounts for more than 40 percent of all travel growth projected through the year 2010.

Other markets also offer export potential. Latin America presents new sales opportunities for U.S. aircraft at rates second only to Asia. The Middle Eastern market is also expected to grow as airline companies replace their aging fleets and governments seek to modernize and replace military aerospace equipment. The opening of the markets of the former Soviet Union also offers new opportunities for U.S. industry.

Although the outlook is promising, competition in the international aeronautics market is becoming increasingly global. European countries have recognized the benefits of a strong civil aeronautics industry. Favored with government subsidies covering both development and production, Europe's Airbus Industries consortium has developed a family of technologically advanced aircraft that compete head-to-head with the full line of U.S. jet transports. A marginal producer in the late 1960s and early 1970s, in 1993 Airbus's share of the world market exceeded 30 percent, with a recently stated goal of capturing over 50 percent.

Europe has also made substantial investments over the past 15 years to construct world-class wind tunnel facilities for aircraft development testing. These facilities are newer and generally have better capabilities than comparable U.S. facilities. This has led to increasing U.S. industrial dependence upon overseas facilities for aerodynamic testing which is eroding their core design and development capabilities.

The Japanese aeronautics industry has historically relied on international cooperation to build up its experience base through joint commercial design, development, and manufacturing ventures and full scale development and production of military vehicles. However, it is seeking to develop its own capabilities in these areas to become a more significant competitor in the next century. Taiwan, Brazil, Indonesia and Korea have also targeted aeronautics as key national industries. Finally, the entry of the Russian and Ukrainian aerospace industries into the commercial market will further heighten the level of competition.

These developments have reduced returns in the industry at the same time that escalating development and production costs have increased the risk associated with the development and launch of new aircraft. As a result, manufacturers have formed alliances and partnerships, often crossing national boundaries, to spread their risk, gain greater leverage from their resources, and strengthen their own core competencies. This highlights the criticality of maintaining technological leadership as the basis for U.S. industrial leadership in aviation.

In addition to managing the globalization process, aeronautics manufacturers face other challenges. There is a strong interest around the world in improving the environmental compatibility of air transportation, that is, in reducing noise and air pollution emissions. There is strong interest, as well, in improving the safety and efficiency of flight operations through improvements in aircraft, air traffic management systems, and human factors design. In much of the world, the air traffic management infrastructure is relatively undeveloped, a situation that represents both a serious challenge and a significant opportunity. Meeting these challenges will be critical to maintaining the industrial, transportation, and social benefits that accrue from a strong aviation system.

Fortunately, the United States can meet these many challenges from a position of strength. The United States is still a leader in both civil and military aircraft and has the basic infrastructure—industry, universities, and government— to support its position. Further, the aircraft industry will continue to benefit from technological investments that decrease the costs and increase the capability of aircraft. Our greatest national challenge is to capitalize and improve on these strengths to meet the challenge of the marketplace.

This effort will require a renewed partnership among government, industry, and academia. True partnership requires investment and risk by all parties. The U.S. Government will continue to invest in high-risk, high-payoff technologies—the private sector lacks the resources and incentive to invest in these areas since the benefits of such high-risk investment will not be realized until far in the future and are difficult for a single firm to fully capture. Public investment is designed to enhance capabilities in transportation, safety, environment, and national security. But the challenges of the current and future markets require that government and industry work together to identify the focus of government-funded cooperative research. Further, rigorous performance measures to assess the success of this partnership must be developed.

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Goals for a National Partnership in Aeronautics Research and Technology

II. U.S. Aeronautics Goals

The aeronautics industry represents the strength of America. High-technology manufacturing and products support hundreds of thousands of jobs and thousands of companies. Superior, next-generation U.S. aircraft, engines, avionics, and air transportation system equipment can lead the way to renewed industrial competitiveness for the 21st century, supporting an industrial base critical for our economy and security.

The vision for our partnership is world leadership in aircraft, engines, avionics, and air transportation system equipment for a sustainable, global aviation system.

To achieve this vision, we will focus on three key goals:

- *Maintain the superiority of U.S. aircraft and engines*
- *Improve the safety, efficiency and cost effectiveness of the global air transportation system*
- *Ensure the long-term environmental compatibility of the aviation system*

In accomplishing these goals, we will pursue the development of high-payoff component technologies, validation and integration of high-risk technologies, as well as the exploration of new concepts to achieve more revolutionary gains.

Maintain the Superiority of U.S. Aircraft and Engines

A prerequisite for superior aircraft is technological superiority in aeronautics. The United States must continue to develop the product and process technologies required for timely, superior subsonic and high-speed civil and military aircraft. Pursuit of technologies that support major improvements in aircraft capabilities can provide a critical edge to maintaining U.S. military aircraft superiority, U.S. civil aircraft competitiveness and improving the affordability of aviation. Without significant investment in these technologies, the United States risks losing the long-term leadership required to maintain a competitive industry.

Maintaining a position of technological leadership requires substantial long-term investment commitment. The significant basic technological commonalty between military and civil aviation products and services must be exploited to increase the productivity and efficiency of our research and technology development activities. This requires government and industry, working together, to actively seek technological goals that are common to both civil and military applications, and to plan responsive technology development programs from the outset. Government must take an active role in bringing together manufacturers, suppliers, and users for early examination and definition of common requirements. DoD, FAA, and NASA must expand their focus on encouraging this early consideration of dual-use applications in technology development programs.

An issue in aeronautics technology development is the extent to which technologies are "validated" as ready for prudent incorporation into an industry product development program. Past military development programs have provided a reasonable degree of validation for technologies applicable to civil products. However, the decline in military development programs, as well as the appearance of some technologies that are largely unique to either sector, has exacerbated this validation issue. It is critical that technology validation efforts be an integral part of our national partnership. To be effective, validation requires programs and facilities capable of providing full-scale data or data that can be confidently extrapolated to full-scale. It is also critical that full use be made of the Department of

Defense's (DoD) technology demonstration efforts for cooperative dual–use technology validation efforts. In the civil sector, it is essential to validate implementation costs and economic benefits of new technologies.

Other factors are also becoming increasingly important. In particular, manufacturers must manage R&D cycle time, as well as the interdependence of technology with design, development, manufacturing, and maintenance processes, in order to meet customer demands regarding life-cycle costs, fleet commonalty and product timeliness.

Subsonic Aircraft

For the foreseeable future, domestic and international air transportation needs will be met primarily by large subsonic transport aircraft. Although subsonic transports are relatively mature by the traditional performance measures of speed and altitude, significant increases in the combination of range and payload as well as major improvements in environmental compatibility, efficiency, reliability, and poor weather operability can be achieved. A reduction in aircraft direct operating costs of 25 percent or more is possible with aggressive pursuit of foreseeable technology advances that will improve the lift-to-drag ratio, increase jet engine efficiency, and reduce aircraft weight. Advanced technology, such as advanced wing designs and high-lift systems, integrated design methodologies, improved propulsion systems, integrated flight and propulsion controls, intelligent systems, and lightweight affordable materials, can enable success.

Given the predicted growth in air transportation, the potential exists for significant market niches for other fixed or rotary wing subsonic vehicles. Technological advances can enable commercial development if market pull creates the necessary conditions for success. For example, civil tiltrotor aircraft offer the promise of expanded airport capacity and increased point-to-point short-haul transportation service. Another example is in the general aviation sector, where the U.S. has been in a long, sustained decline in the number of vehicles produced and overall market share. The potential exists, with new technology, to develop safer, more efficient, easier-to-fly aircraft for both business and personal transportation.

The military needs more affordable subsonic aircraft, which means increased capability at reduced cost and size. Greater range and payload capability, reduced signatures, and increased survivability in military rotorcraft, patrol aircraft, and transports offer substantial increases in military capability at reduced cost. These benefits are achievable through technological advances that include more affordable, higher performance turbine engines, light weight structures, integrated flight/thrust-vectoring propulsion control systems, and reduced signatures. Such advances also offer the potential of a fighter-size short-take-off-and-vertical-landing aircraft with greater range/payload capability.

Our partnership must focus on the identification of technological goals and the execution of programs that will enable these improvements in subsonic aircraft. Full advantage must be taken of the synergy between military and civil applications, particularly in the formulation of common technological goals.

High-Speed Aircraft

Projected growth in the long-range commercial market presents a strategic opportunity for U.S. industry to retain its preeminent position in the aeronautics marketplace through successful development and production of a high-speed (Mach 2 -2.5) civil transport (HSCT) aircraft. Market studies estimate that an average of 600,000 passengers per day flying over long, predominantly trans-oceanic routes could support 500 to 1000 HSCT aircraft between 2005 and 2015. Such a vehicle could revolutionize air transportation in the next century by reducing global transportation times significantly, and allowing an even greater level of global economic and cultural integration.

The capability for sustained supersonic flight has existed for many years. But, as the difficulties faced by the Concorde transport have demonstrated, successful high-speed civil aircraft must also satisfy both market and environmental requirements. To date, the required technology to meet these requirements has

not been available. Over the last several years, however, intensive government and industry research indicate that such technology is finally within our grasp. These technologies include light-weight, high performance engines, ultra-low emission combustors, light-weight airframe materials, advanced subsystems, and advanced aerodynamics.

Transonic and supersonic aircraft will continue to be the mainstay of military air combat power. Foreseeable technology advances that include high performance, more affordable engines, light-weight structures, and advanced subsystems offer large increases in the sustained cruise speed, range, responsiveness, and combat capability of these types of aircraft at reduced cost.

Again, our partnership must focus on the identification of technological goals and the execution of programs that will enable these improvements. In the case of a commercial high speed transport, the risk level associated with the necessary technology development required for commercial go-ahead exceeds industry's ability to independently pursue a timely R&T program. Therefore, specific efforts to develop the technical data base required for commercial development of an environmentally-compatible high speed civil transport is a key element.

Design and Manufacturing

The future of American aeronautics lies not just in the development of new aircraft, but in the improvement of design and manufacturing processes. Decreasing the time and cost required to design and manufacture aircraft can increase the competitiveness of U.S. manufacturers and the affordability of air transportation and national security. Aircraft are extremely complex, and the cost to develop a new one can be several billion dollars. U.S. manufacturers are squeezed by demands for more efficient and affordable aircraft while having to compete against subsidized foreign competitors.

Traditionally, government has contributed to private sector efforts by supporting generic test facilities and methodologies applicable to aircraft design and development. Provision of these facilities and methodologies has lowered barriers to entry into, and increased competition in, the industry. Current developments in computing and communications, modeling, simulation and virtual reality, neural networks and intelligent systems, non-intrusive instrumentation, advanced flexible manufacturing, physics-based manufacturing modeling, and lean production concepts hold the promise for reductions—ranging from 30 to 50 percent—in the time and cost required to design, develop, and produce new aircraft.

Significant challenges exist in the development and integration of these technologies into aircraft design and manufacturing processes characterized by large scale, high cost, and infrequent new starts. Our partnership should focus on high leverage 'building blocks' that will contribute to greater integration of the civil and military design and manufacturing base, and that can complement industry efforts at overall process improvement to ensure payoff and timeliness.

The Aeronautics R&D Infrastructure

Aeronautics relies on a base of large-scale generic facilities and basic disciplinary research. The primary aeronautics-specific facilities consist of wind tunnel, simulator, computational, and flight test facilities. These facilities, together with basic aeronautical disciplinary research, such as boundary layer transition and turbulence research, characterization of composite materials, and computational physiological modeling for human factors, provides the R&D infrastructure for the U.S. aeronautics community. Sustaining U.S. capabilities in the development of superior aircraft requires continued investment in this R&D infrastructure. Traditionally, this investment has been spread over government R&D laboratories, industry, and universities. However, because of the large-scale, generic nature of aeronautical facilities and the very long payback period and generic nature of basic disciplinary research, the federal government has taken a lead role in the provision and funding of this R&D infrastructure.

Currently, the severe pressure in both the civil and military markets has led to a serious reduction in military and industry investment in research, development, test, and evaluation. In the long-term,

continued reduction in these investments will significantly decrease the flow of technology and human resources available to aeronautics and the nation. This trend, together with the drive toward increasing the payoff of our nation's research investment by increasing the emphasis on validation and commercialization, makes it important to evaluate this nation's aeronautics research programs across government, industry, and academia, with the goal of ensuring adequate breadth and depth in critical technology areas and developing metrics to assess performance.

The U.S. maintains a broad base of world class facilities for the full spectrum of R&D needs. However, newer European wind tunnels focused on aircraft development testing are generally superior to comparable U.S. facilities in overall capability. This has led to increasing utilization of European facilities for U.S. commercial aircraft development testing, creating facilities access and data security risks. The United States needs to maintain national facilities with adequate capability and capacity to satisfy both civil and military requirements.

Improve the Safety, Efficiency and Cost Effectiveness of the Global Air Transportation System

In some instances, congested airports are undergoing expansion and modernization to meet the ever increasing level of air traffic. In the meantime, continued modernization of communications and navigation systems is playing a significant role in accommodating air travel growth. The adoption of common air traffic management system standards and procedures through collaborative efforts among the Federal Aviation Administration (FAA), RTCA, Inc. and the International Civil Aviation Organization (ICAO) is essential in this process.

Of particular interest to U.S. airlines, general aviation operators, and aircraft manufacturers is the adoption of the U.S. Global Positioning System (GPS) as an element of an internationally accepted Global Navigation Satellite System (GNSS). Industry estimates that airlines worldwide will save as much as $5 billion annually in fuel and other costs when this capability is fully implemented in conjunction with other evolutionary improvements in air traffic management capabilities.

Efforts to improve communications are focused on establishing a robust air-ground data link, in particular, an aeronautical telecommunications network that will be capable of cost-effectively transfer large quantities of information between aircraft and the ground systems that support them. A second initiative is exploiting satellite- based communications for civil aviation applications.

The greatest potential growth in air traffic, and hence in aircraft sales, exists in global regions that have limited air traffic management (ATM) infrastructure today. ATM systems utilizing GNSS and satellite-based data link capabilities are being developed and implemented in some of these regions. The movement toward these new capabilities is having a significant positive effect on aircraft market potential and the efficiency of flight operations while creating a lucrative market for new avionics equipment worldwide. These events illustrate the benefits of U.S. leadership in the development and implementation of a superior, affordable, global air transportation system.

System Capacity and Efficiency

Capacity in the global airspace system is not uniformly distributed and capacity problems vary widely among regions. In 1992 in the U.S., 23 primary airports each experienced more than 20,000 hours of flight delay. The cost to airlines and passengers exceeded $8 billion. By 2002, 33 airports are forecast to reach that level of delay. Improvements in terminal area ATM capabilities, airport expansions and, to a lesser degree, new airport construction will contribute to an alleviation of this problem.

Congestion at European airports, measured by flight delays in excess of 15 minutes, has risen sharply since the mid- 1980s. Currently, about one quarter of all flights are delayed by 15 minutes or more with significant costs to both passengers and airlines. If nothing is done, 11 of Europe's 27 primary airports will be capacity constrained by 1995, rising to 16 in 2000. At the same time, forecast traffic growth will cause airspace congestion. This problem has attracted political attention and the European Civil Aviation

Conference has endorsed a plan to harmonize and restructure the disparate national air traffic control systems to improve capacity. However, Europe's main long-term problem remains its lack of sufficient runway capacity.

Capacity problems in Asia are the reverse of those in Europe. New airports are being built and major expansions are taking place at existing ones. However, airspace problems which need multinational coordination to resolve are prevalent. North Pacific routes are already saturated as are those over the South China Sea between the Hong Kong/Taiwan region and the Singapore/Australia region. Routes crossing the India/Pakistan border are inadequate for the traffic from Europe to the southern Asia/Pacific region. As Soviet airspace opens, more northerly tracks over the North Pacific will become available allowing the jet stream to be avoided and shortening flight distances.

Globally, airspace system capacity improvement must include a number of interrelated actions. More runway capacity must be developed where it is needed by better utilizing existing runways and/or by constructing new runways that are efficient in design, construction cost and maintenance requirements. Airports must be accessible for operators of all vehicle types. Full accessibility will insure that the dynamics of the marketplace determine the best aircraft for a particular service. Full accessibility becomes an increasingly difficult issue as totally new types of aircraft, such as high-speed civil transports and civil tiltrotors, enter service. The difficulty arises in sequencing aircraft of widely differing flight characteristics into safe and efficient arrival and departure streams at airports.

New technology is available that will significantly change the way airspace is managed. These technologies - which include satellite-based communications and navigation, data link communications, automatic dependent surveillance, and automation - are now being introduced into aeronautical products and services, airports, and air traffic management systems. The capabilities provided will increase capacity as well as the flexibility and efficiency with which airspace is managed. Air traffic management service providers and system users will have a more collaborative relationship. Before these benefits can be fully realized, however, significant challenges in the integration of space-based, ground-based and airborne systems must be resolved. Focusing our partnership on systems integration and on development of the associated standards and procedures for air traffic management will increase our ability to cost-effectively exploit these technologies thereby improving U.S. industry's position in the marketplace while improving the affordability of aviation worldwide.

Safety and Security

The continuous introduction of new safety technology, such as wind shear alerting systems, ground proximity warning systems, higher strength seats, seat fire-blocking layers, advanced simulation and training techniques, and cabin floor emergency escape lighting, has allowed significant growth in air traffic while maintaining an excellent safety record. Clearly, continued growth in aviation activity requires continued improvements in aviation safety. There are a number of areas where significant safety improvements may be possible in the near-term. For example, better understanding of wake vortex effects and avoidance procedures will increase operational safety.

An adequate understanding of human factors and the effective application of this knowledge is increasing important. Automation is an essential tool for further improving the safety and efficiency of flight operations. But automation is beneficial only where it interfaces effectively with human operators. A national program in aviation human factors is required to develop the knowledge base and application tools required.

Security considerations are also important, especially in international aviation. Unfortunately, the end of the Cold War has not eliminated threats to airline security. A recent study noted that between 1980 and 1990, 28,459 weapons were detected by airport screening devices worldwide. During the same period, 38 hijackings were believed to have been averted with the help of screening devices. Hence the threat posed by terrorism remains.

It is imperative that the United States continue to develop technology, procedures, and the appropriate standards to enhance aviation safety and security. The breadth of technologies and issues requires a

broad partnership focused on the development, integration, validation, and certification of such technologies. Working in partnership increases the effectiveness of the development process, allowing technology insertion to occur more rapidly and more efficiently.

Ensure the Environmental Compatibility of Aviation

Remarkable strides have been made in reducing the adverse impacts of aircraft on the environment. Noise and harmful emissions have been diminished with the introduction of each new and derivative aircraft. Today's high- bypass ratio turbofan engines are quiet, efficient, and reliable. Past research investments in technologies to reduce engine noise and emissions are paying dividends today. But more needs to be done. Environmental issues are likely to impose the fundamental limitation on air transportation growth in the 21st century.

As noise associated with the rotating machinery of jet engines has been reduced, aerodynamic and airframe noise has become a larger share of the total noise produced by aircraft. We must therefore seek innovative solutions to reduce both exterior and cabin noise from all sources. This includes the systematic development and validation of additional technologies to reduce engine and airframe noise and the development of flight procedures to reduce community noise exposure.

Because of the significant public benefits from aircraft noise reduction, the U.S. has been aggressive in technology development and application. A U.S. regulation is now in effect to expedite the phaseout of operations of the noisiest aircraft, (called Stage 2) by the year 2000. With the full phase-in of the quieter aircraft (Stage 3), the number of people strongly affected by noise will fall from about 2.7 million to 400,000. After the year 2000, the number of people significantly impacted by noise will slowly start to rise due to the increasing number of flights needed to meet the demand for transportation. The increase in noise impact will be a consequence of the fact that noise impact is a function of both the noise level of each event and the total number of events. Clearly, as the worldwide demand for quieter aircraft intensifies, an aircraft's market share will be strongly influenced by the noise it generates.

Social and political pressures are growing to increase the stringency of aircraft engine emission standards. At present there is insufficient scientific evidence to support such measures or rational, cost-effective actions. Clearly, atmospheric modeling and research must continue in order to inform the policy-making process. Significant increases in energy efficiency and decreases in the emission of noxious chemicals have been realized over the past 30 years. Current challenges vary between general aviation, subsonic transports, and potential second-generation supersonic transports, but the research and technology goal across the board is to increase energy efficiency while decreasing noxious and ozone-depleting chemicals. Our partnership will continue to improve engine technology, such as very high pressure ratio engines and new combustors, to ensure long-term improvement in the environmental compatibility of aviation. In the case of second-generation supersonic transports, enabling technology for environmentally-clean engines that do not impact the earth's ozone layer is a principal requirement for successful development.

The U.S. must maintain leadership in these technologies to ensure the environmental compatibility of aviation and long-term competitiveness. Therefore, our partnership will pursue the development and application of noise and emission reduction technology.

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Goals for a National Partnership in Aeronautics Research and Technology

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III. A New Aeronautics Partnership

Partnership has propelled powered flight, in little more than the span of a single lifetime, from its roots at Kitty Hawk, to today's global aviation system that connects cultures and economies. Aviation will remain at the forefront of global transportation, communications and commerce, as well as remain an indispensable tool of national security. A new partnership between government, industry, and universities will allow the U.S. to meet the many challenges it faces in aeronautics and to maintain its position as a global leader.

The Administration, in cooperation with industry and academia, has developed the common goals outlined in this document. This is an important first step, providing a framework for partnership. Through the National Science and Technology Council (NSTC), the next step is to establish an integrated national strategy and a set of investment priorities that will enable us to meet these broad goals.

Over the course of the next year, the NSTC, in partnership with industry and academia, will perform a national assessment to guide the direction and character of the Federal investment in U.S. civil aviation technology for the future. The assessment will include development of top-level technical goals, roadmaps to achieve the goals, partnership mechanisms, and analyses of benefits, priorities, opportunity costs, roles and responsibilities, and interrelationships with other national initiatives.

This document, together with the detailed national assessment, will provide the blueprint for our public-private partnership for the future, as well as communicate with the American people and the Congress our proposed investment portfolio. The NSTC welcomes comments and participation in the planning process as we move to ensure the technology base and infrastructure for a vital aviation industry and transportation system.

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